



Survivorship Analysis in Asymptomatic COVID-19+ Hip Fracture Patients: Is There an Increase in Mortality?

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Purpose: Mortality rates following hip fracture surgery have been well-studied. This study was conducted to examine mortality rates in asymptomatic patients presenting for treatment of acute hip fractures with concurrent positive COVID-19(+) tests compared to those with negative COVID-19(-) tests.

Materials and Methods: A total of 149 consecutive patients undergoing hip fracture surgery during the COVID-19 pandemic at two academic medical centers were reviewed retrospectively. Patients were divided into two groups for comparative analysis: one group included asymptomatic patients with COVID-19+ tests versus COVID-19- tests. The primary outcome was mortality at 30-days and 90-days.

Results: COVID-19+ patients had a higher mortality rate than COVID-19- patients at 30-days (26.7% vs 6.0%, $P=0.005$) and 90-days (41.7% vs 17.2%, $P=0.046$) and trended towards an increased length of hospital stay (10.1 ± 6.2 vs 6.8 ± 3.8 days, $P=0.06$). COVID-19+ patients had more pre-existing respiratory disease (46.7% vs 11.2%, $P=0.0002$). Results of a Cox regression analysis showed an increased risk of mortality at 30-days and 90-days from COVID-19+ status alone without an increased risk of death in patients with pre-existing chronic respiratory disease.

Conclusion: Factors including time to surgery, age, preexisting comorbidities, and postoperative ambulatory status have been proven to affect mortality and complications in hip fracture patients; however, a positive COVID-19 test result adds another variable to this process. Implementation of protocols that will promote prompt orthogeriatric assessments, expedite patient transfer, limit operating room traffic, and optimize anesthesia time can preserve the standard of care in this unique patient population.

Key Words: Geriatric, Hip, Fracture, Mortality, COVID-19

Submitted: September 20, 2021 **1st revision:** January 6, 2022
2nd revision: January 14, 2022 **Final acceptance:** January 14, 2022

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INTRODUCTION

In the United States hip fractures occur in more than 250,000 people per year and are a common cause of premature mortality; as a result in this pathology is regarded as a worldwide epidemic¹⁻⁵. With the continued increase in life expectancy of the world population, the importance of outcomes in hip fracture patients will increase as the incidence of hip fractures increases^{3,4}. Mortality rates following orthopedic intervention for treatment of hip fractures have been well-studied; various patient risk factors for mortality, including age, preexisting medical conditions, time to surgery, and postoperative level of ambulation have been identified⁶. Mortality rates range between 11-23% at six months and 22-29% at one year^{3,6}. While the impact of hip fractures on patient mortality has been well-studied, understanding of the effect of COVID-19 within this patient population is limited.

The impact of the novel COVID-19 pandemic on the medical community as a whole has been significant, and the field of orthopedics is no exception. Concomitant diagnosis of COVID-19 in patients with hip fracture represents a new variable that must be considered when evaluating mortality rates; this has not been previously described in the literature. As we are in the midst of the COVID-19 outbreak, there is little data regarding mortality risk in patients with perioperative positive COVID-19 test results undergoing surgical intervention, and the risk for adverse outcomes in this patient population remains controversial^{7,8}. Studies evaluating mortality rates in patients undergoing surgical intervention for treatment of acute hip fractures who have a positive COVID-19 status but are asymptomatic compared to those with a negative COVID-19 status are needed, as this would provide valuable information for use in determining whether COVID-19 status can affect mortality even without a symptomatic presentation at the time of surgery. Findings from early studies revealed an unexpectedly high mortality rate of 20% in COVID-19 infected patients undergoing generalized surgical procedures, significantly higher than that of COVID-19 negative patients, as well as significantly higher rates of postoperative pulmonary and thrombotic complications^{7,8}. Initial studies evaluating outcomes of orthopedic procedures during the COVID-19 pandemic reported an increased risk of morbidity and mortality for patients with a positive perioperative COVID-19 diagnosis^{9,10}.

Many precautions are required preoperatively, intraoperatively, and postoperatively for orthopedic intervention in

patients with a positive COVID-19 status. Significant influence on surgical mortality would warrant changes to treatment plans at each stage of care. The goal of this retrospective analysis was to examine the mortality rates in patients presenting for treatment of acute hip fractures with concurrent positive COVID-19 tests but asymptomatic COVID-19 status compared to those with negative COVID-19 tests since the beginning of the COVID-19 pandemic.

MATERIALS AND METHODS

This was a retrospective consecutive case series of all patients undergoing hip fracture surgery between March 2020 and March 2021. A retrospective review of our institution's hip fracture registry data was conducted for identification of patients. The majority of hip fractures were fragility fractures in elderly patients; however, higher energy hip fractures in younger patients were included as well. All patients were treated by one of four experienced attending orthopedic surgeons at one of two academic medical centers. A total of 202 consecutive patients were treated for hip fractures during this period (89 femoral neck fractures [FNF], 88 intertrochanteric fractures [ITF], 11 intertrochanteric fractures with subtrochanteric extension [ITST], and 14 subtrochanteric fractures [STF]). This study was approved by the WCG IRB (No. 20171537), and the informed consent was waived by the IRB. We conducted this study in compliance with the principles of the Declaration of Helsinki (2013).

All cause mortality at 30 days and 90 days was the primary outcome of interest. Patients who did not have at least 30-day follow-up postoperatively (n=47) or a documented COVID-19 test in their electronic medical record (n=6) were excluded from analysis (Fig. 1). Patients who had greater than 30-day follow-up but less than 90-day follow-up were not included in the 90-day mortality analysis (n=41) unless they had already passed away. All COVID-19 tests performed in the institutions were rapid COVID-19 polymerase chain reaction nasal swab tests. The institutional policy for COVID-19+ patients is to delay surgery for symptomatic patients, therefore all patients in the cohort were asymptomatic at the time of surgery. Symptomatic patients are defined as patients presenting with any symptoms associated with the COVID-19 virus, including fever, cough, shortness of breath, and more. Asymptomatic patients are defined as those who do not complain of any symptoms associated with the COVID-19 virus at the time of their admission leading up to their surgical intervention. To be cleared for surgery, in

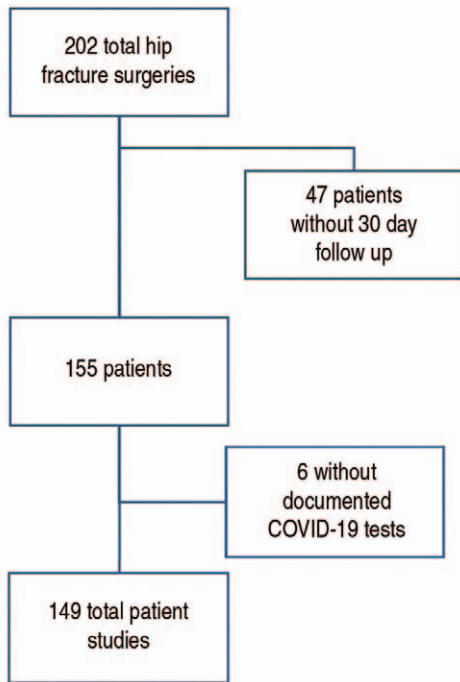


Fig. 1. Flow chart documenting exclusion and inclusion criteria.

these patients were required to have negative preoperative evaluations, including negative lab results and radiologic findings on chest X-ray. The majority of COVID-19 positive patients who underwent surgery remained asymptomatic throughout their hospital course, while a few developed symptoms during the postoperative period.

The study cohort included 134 patients who were COVID-19– and 15 patients who were COVID-19+. Demographic, perioperative, and postoperative data was collected from the electronic medical record and an online search of patient obituaries was performed. Variables of interest included comorbidities, the American Society of Anesthesiologists (ASA) physical status classification system score, smoking status, chronic anticoagulation, fracture diagnosis, treatment modality, time from admission to surgery, length of surgery, length of hospital stay, tranexamic acid (TXA) use, preoperative and postoperative hemoglobin (Hgb) levels, and intraoperative and postoperative transfusions.

IBM SPSS Statistics (ver. 25; IBM, Armonk, NY, USA) was used in performance of all statistical analyses. A standard deviation variation test was used to test the normality

Table 1. Demographic Comparison between Cohorts

Demographic variable	COVID-19+	COVID-19–	P-value
No. of patients	15	134	
Age (yr)	74.0±21.0	78.4±16.1	0.34
Sex, female	11 (73.3)	98 (73.1)	>0.99
Side, right	8 (53.3)	71 (53.0)	>0.99
Body mass index (kg/m ²)	25.4±3.2	24.9±5.7	0.63
ASA [†]			0.29
1	0	4 (3.1)	
2	2 (15.4)	36 (27.7)	
3	9 (69.2)	75 (57.7)	
4	2 (15.4)	15 (11.5)	
Chronic anticoagulation	9 (60.0)	58 (43.3)	0.22
Diabetes	3 (20.0)	24 (17.9)	0.74
Renal disease	1 (6.7)	19 (14.2)	0.69
Liver disease	0	2 (1.5)	>0.99
Chronic respiratory disease	7 (46.7)	15 (11.2)	0.0002*
Heart disease	3 (20.0)	36 (26.9)	0.76
Coagulopathy	3 (20.0)	37 (27.6)	0.76
Cancer	3 (20.0)	27 (20.1)	>0.99
Dementia	4 (26.7)	31 (23.1)	0.75
Smoker			0.51
No	12 (80.0)	117 (87.3)	
Yes	1 (6.7)	7 (5.2)	
Former	2 (13.3)	10 (7.5)	

Values are presented as number only, mean±standard deviation, or number (%).

Cohorts were similar in terms of all variables analyzed with the exception of pre-existing chronic respiratory disease [Asthma/COPD, P=0.0002].

ASA: American Society of Anesthesiologists.

* P≤0.05.

† Sums may not add up to the total amount due to missing data.

of continuous variables. A *t*-test was used for comparison of normal continuous variables, while a Mann–Whitney U test was used for comparison of non-normal continuous variables. Due to the small sample size of our COVID-19+ cohort, Fisher’s exact test was used for comparison of categorical variables. Univariate and multivariate Cox proportional hazards regression and linear regression models were performed for comparison of 30-day and 90-day mortality rates and length of hospital stay, respectively, to account for any demographic differences between the two cohorts and to account for multicollinearity between variables. These findings were reported as a hazards ratio (HR) for Cox regression and an unstandardized beta (β) coefficient for

linear regression with an associated 95% confidence interval (CI). A Kaplan–Meier method was used in performance of survival analyses. A log-rank test was used for testing survival curves for comparison of overall estimated survival between cohorts. A *P*-value ≤ 0.05 was considered statistically significant.

RESULTS

A total of 134 COVID-19– patients and 15 COVID-19+ patients who were identified met the inclusion criteria. All patients underwent operative intervention for an FNF, ITF, ITST, or STF. Comparison of demographic variables

Table 2. Perioperative Data between Cohorts

Variable	COVID-19+	COVID-19–	<i>P</i> -value
No. of patients	15	134	
Diagnosis			0.53
Femoral neck fracture	8 (53.3)	62 (46.3)	
Intertrochanteric fracture	6 (40.0)	55 (41.0)	
IT Fracture with ST extension	1 (6.7)	10 (7.5)	
Subtrochanteric fracture	0	7 (5.2)	
Type of implant			0.76
Short IMN	1 (6.7)	10 (7.5)	
Long IMN	6 (40.0)	65 (48.5)	
HHA	7 (46.7)	40 (29.9)	
THA	0	8 (6.0)	
CRPP	0	2 (1.5)	
Flexi-nails	1 (6.7)	2 (1.5)	
Sliding hip screw	0	3 (2.2)	
Femoral neck plate	0	6 (4.5)	
Polytrauma	1 (6.7)	12 (9.0)	>0.99
Time to surgery (hr)	30.0±20.4	30.0±27.1	>0.99
Length of surgery (min)	74.4±36.7	73.3±34.5	0.91
Length of stay (day)	10.1±6.2	6.8±3.8	0.06
TXA use	2 (13.3)	27 (20.1)	0.74
Preoperative Hgb (g/dL)	11.6±1.9	11.8±1.8	0.67
Postoperative Hgb (g/dL)	8.9±1.6	8.7±1.8	0.71
Transfusion intraoperative	0 (0)	7 (5.2)	0.37
Transfusion postoperative	5 (33.3)	49 (36.6)	0.92
30-day mortality	4 (26.7)	8 (6.0)	0.005*
Alive (total n)	11	126	
Dead (total n)	4	8	
90-day mortality†	5/12 (41.7)	16/93 (17.2)	0.046*
Alive (total n)	7	77	
Dead (total n)	5	16	
Reoperation	2 (13.3)	6 (4.5)	0.19
Follow-up (mo)	3.8±3.4	4.1±2.9	0.73

Length of stay and 90-day mortality trended toward significantly longer/greater in the COVID-19+ cohort (*P*=0.06) and 30-day mortality was significantly greater in the COVID-19+ cohort (*P*=0.02).

IT: intertrochanteric, ST: subtrochanteric, IMN: intramedullary nail, HHA: hemi-hip arthroplasty, THA: total hip arthroplasty, CRPP: closed reduction percutaneous pinning, TXA: tranexamic acid, Hgb: hemoglobin.

* *P*≤0.05.

† Sums may not add up to the total amount due to missing data.

between cohorts showed similar attributes in all variables but one (Table 1). Pre-existing chronic respiratory conditions (COPD/Asthma) were more prevalent in the COVID-19+ group ($P=0.0002$). Of note, no difference in age, sex, body mass index, ASA, coagulopathy, or smoking status was observed between groups. Results of a Cox regression

analysis revealed no difference in mortality risk in patients with pre-existing chronic respiratory disease and mortality at 30 days (HR, 1.966; 95% CI, 0.532-7.263; $P=0.311$) or at 90 days (HR, 0.886; 95% CI, 0.261-3.009; $P=0.846$). Even after accounting for multicollinearity with COVID-19 status, the risk remained insignificant for mortality at 30 days

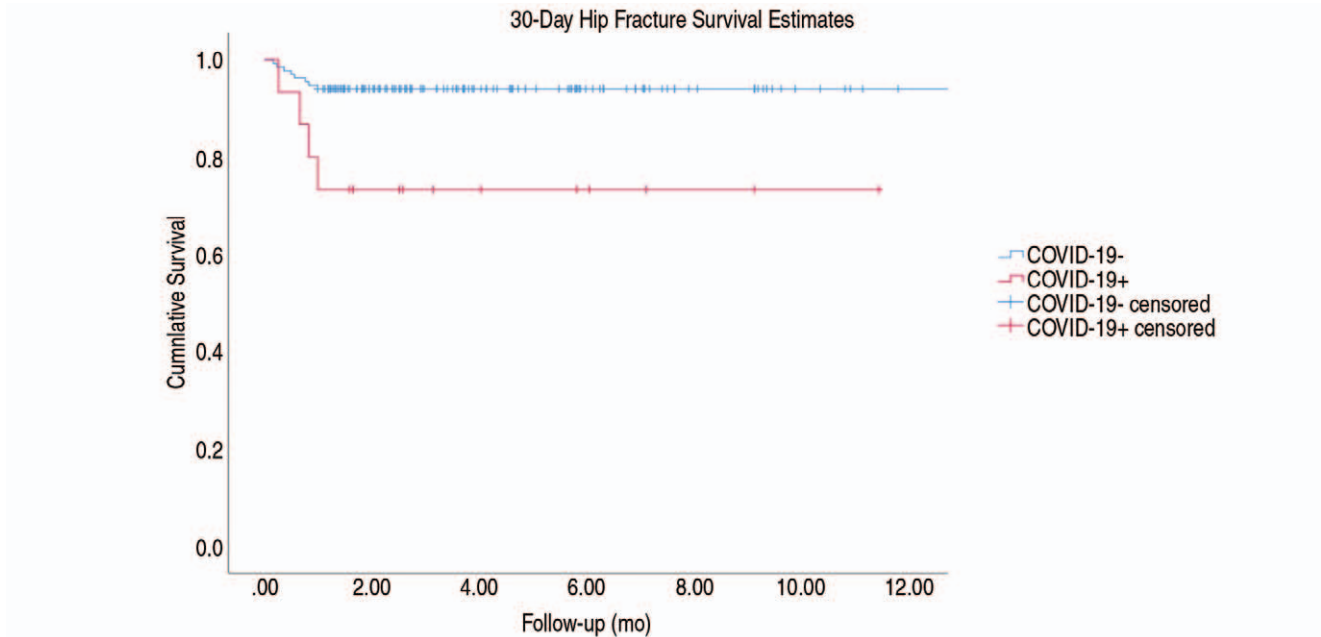


Fig. 2. 30-day hip fracture survival estimates, Log-rank $P=0.005$. Mean survival time COVID-19- is 12.065 months [95% confidence interval [CI], 11.573-12.556]. Mean survival time COVID-19+ is 8.529 months [95% CI, 6.133-10.924].

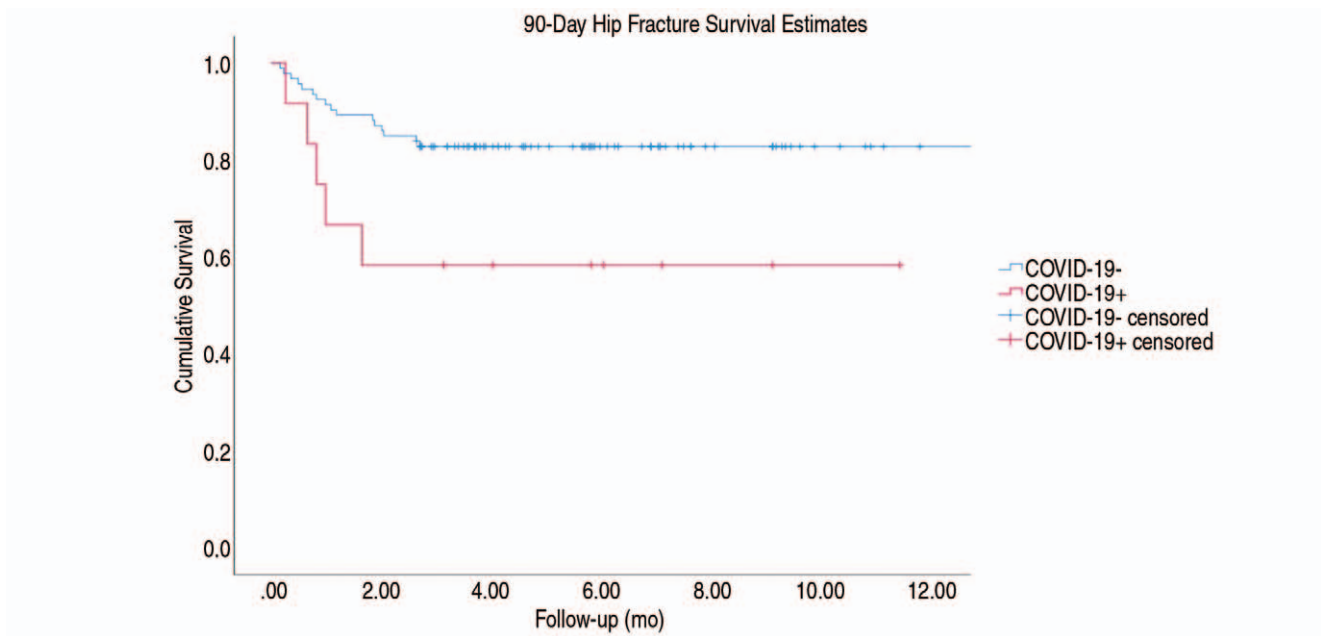


Fig. 3. 90-day hip fracture survival estimates, Log-rank $P=0.027$. Mean survival time COVID-19- is 10.805 months [95% confidence interval [CI], 9.915-11.695]. Mean survival time COVID-19+ is 7.004 months [95% CI, 4.068-9.939].

(HR, 1.220; 95% CI, 0.299-4.976; $P=0.781$) and 90 days (HR, 0.630; 95% CI, 0.175-2.264; $P=0.479$).

Perioperative variables including diagnosis and type of implant used during the procedure are presented in Table 2. No difference in time to surgery, length of surgery, preoperative or postoperative Hgb levels, or transfusions was observed between the groups. An increased length of stay that trended towards significant was observed for the COVID-19+ group as these patients averaged 3.3 more days in the hospital than patients without COVID-19 ($P=0.06$). Results of a univariate linear regression analysis revealed an association between patients with a history of preexisting chronic respiratory disease and an increased length of stay (unstandardized β , 2.130; 95% CI, 0.239-4.020; $P=0.028$). However, after adjusting the model for multicollinearity with COVID-19 status, there was no difference in unstandardized β (unstandardized β , 1.393; 95% CI, -0.555 to 3.341; $P=0.160$).

Kaplan–Meier survival estimates for each cohort are presented in Fig. 2 and 3. A significantly lower mean survival time was observed for COVID-19 positive patients compared with that for COVID-19 negative patients at 30 days (8.529 months [95% CI, 6.133-10.924] vs 12.065 months [95% CI, 11.573-12.556]; $P=0.005$) and at 90 days (7.004 months [95% CI, 4.068-9.939] vs 10.805 months [95% CI, 9.915-11.695]; $P=0.027$). A significantly higher mortality rate was observed for COVID-19+ patients compared to COVID-19– patients at 30 days (26.7% vs 6.0%; $P=0.005$) and 90 days (41.7% vs 17.2%; $P=0.046$) (Table 2). Due to lack of follow up, cause of death was not obtained for all patients; however, known causes of death in the cohort include cardiac arrest, septic shock, respiratory failure, thromboembolism, and pulmonary embolism. No difference in reoperation rates was observed between groups ($P=0.19$). In addition, results of a regression analyses revealed that COVID-19 positive status conferred an increased risk of 30-day mortality ($P=0.011$) and 90-day mortality ($P=0.036$), and an increased risk of length of stay ($P=0.003$), which remained consistent even after adjusting for multicollinearity with pre-existing chronic respiratory disease (Table 3).

DISCUSSION

This study provides a comparative analysis of 30-day and 90-day mortality rates between asymptomatic COVID-19 positive and COVID-19 negative patients undergoing surgical intervention for treatment of hip fractures since the start of the COVID-19 pandemic in March 2020. The main

Table 3. Cox and Linear Regression Analyses for 30-Day Mortality, 90-Day Mortality, and Length of Stay

Variable	30-day mortality			90-day mortality			Length of stay		
	Univariate HR (95% CI)	P	Multivariate HR (95% CI)	Univariate HR (95% CI)	P	Multivariate HR (95% CI)	Univariate unstandardized beta (95% CI)	P	Multivariate unstandardized beta (95% CI)
COVID-19 status									
Negative (ref.)	-	-	-	-	-	-	-	-	-
Positive	4.766 (1.435-15.835)	0.011	4.468 (1.229-16.249)	2.940 (1.075-8.043)	0.036	3.339 (1.165-9.568)	3.380 (1.182-5.577)	0.003	2.885 (0.588-5.182)
Pre-existing pulmonary disease									
None (ref.)	-	-	-	-	-	-	-	-	-
Positive history	1.966 (0.532-7.263)	0.311	1.220 (0.299-4.976)	0.886 (0.261-3.009)	0.846	0.630 (0.175-2.264)	2.130 (0.239-4.020)	0.028	1.393 (-0.555-3.341)

HR: hazards ratio, CI: confidence interval, ref.: reference.

findings of this study can be summarized into three categories. First, among all preoperative variables analyzed in this study, more chronic respiratory disease was observed for COVID-19 positive patients compared with COVID-19 negative patients. Second, a higher risk of mortality was observed for asymptomatic hip fracture patients with a positive COVID-19 status at 30 days (26.7% vs 8.7%; $P=0.005$) and 90 days (41.7% vs 17.2%; $P=0.046$) compared to COVID-19 negative patients without an increased risk of mortality in patients with pre-existing respiratory disease. Third, a trend towards an increased length of hospital stay was observed for COVID-19 positive patients compared to COVID-19 negative patients (10.1 ± 6.2 days vs 6.8 ± 3.8 days; $P=0.06$).

To the best of our knowledge, no previous studies comparing mortality rates in asymptomatic COVID-19 positive and COVID-19 negative hip fracture patients have been reported. Findings of our study demonstrate that hip fracture patients who are COVID-19 positive, while asymptomatic, have a significantly higher 30-day and 90-day mortality rates compared to patients with similar characteristics but have negative COVID-19 tests. Investigations of overall surgical outcomes and mortality in COVID-19 positive patients are lacking in general, and early data in orthopedic surgery remains controversial but suggests a significant risk of morbidity and mortality⁸⁻¹⁰. A few recent studies investigating mortality in hip fracture patients with COVID-19 have been conducted; however, these studies do not indicate the severity of COVID-19 symptoms or lack of symptoms at the time of surgery, such as our cohort¹¹⁻¹³. COVID-19 can remain asymptomatic in a large percent of patients, and quantifying the risk represented by this status to patients undergoing surgical intervention for treatment of hip fractures is important. This study further investigates outcomes specifically in asymptomatic COVID-19 positive patients, therefore we consider it as a supplement to the recent literature. The results indicate that 30-day and 90-day mortality rates are still significantly increased for these patients despite being asymptomatic at the time of surgery.

Aside from COVID-19 status, preexisting chronic respiratory disease was the only significantly different patient characteristic or comorbidity in these populations. This comorbidity may play a role in patient outcomes, as these patients are more likely to contract the virus and undergo severe progression of the disease¹⁴⁻¹⁶. It is possible that this increased incidence of preexisting chronic respiratory disease in the COVID-19 positive group contributed to the

higher mortality rate in this cohort. However, according to the results of our Cox regression analyses, preexisting chronic respiratory disease did not affect mortality rate at 30 days or 90 days. Results of a univariate Cox regression analysis showed no difference in mortality risk in patients with pre-existing chronic respiratory disease and mortality at 30 days (HR, 1.966; 95% CI, 0.532-7.263; $P=0.311$) or at 90 days (HR, 0.886; 95% CI, 0.261-3.009; $P=0.846$). When accounting for multicollinearity with COVID-19 status, the mortality risk remained insignificant at 30 days (HR, 1.220; 95% CI, 0.299-4.976; $P=0.781$) and at 90 days (HR, 0.630; 95% CI, 0.175-2.264; $P=0.479$). Based on these findings, it can be concluded that preexisting chronic respiratory disease did not affect mortality rates, and the increased mortality rates observed in this study can be attributed to the positive COVID-19 status alone. Thus, if preexisting chronic respiratory disease is in fact a confounding variable, then it is reasonable to conclude that preexisting chronic respiratory disease is an important risk factor to consider when evaluating the risks of hip fracture surgery in asymptomatic COVID-19 positive patients. This conclusion would provide valuable information for use in evaluation of asymptomatic COVID-19 patients with hip fractures and future studies should be conducted for further investigation.

It appeared that length of hospital stay was elevated in COVID-19 positive patients as well, although this did not quite reach statistical significance ($P=0.06$). However, results of univariate linear regression analysis showed a significant association between length of stay and positive COVID-19 status (unstandardized β , 3.380; 95% CI, 1.182-5.577; $P=0.003$). A univariate linear regression analysis was also used to examine association between preexisting chronic respiratory disease and length of stay; the results showed an association between preexisting chronic respiratory disease and an increased length of stay (unstandardized β , 2.130; 95% CI, 0.239-4.020; $P=0.028$). However, after adjusting the model for multicollinearity with COVID-19 status, there was no difference in unstandardized β (unstandardized β , 1.393; 95% CI, -0.555 to 3.341; $P=0.160$). Because preexisting chronic respiratory disease no longer showed a significant association with increased length of stay once multicollinearity with COVID-19 status was accounted for, these findings suggest that positive COVID-19 status alone was truly associated with increased length of stay and that preexisting chronic respiratory disease had no effect.

Conduct of further investigation is warranted to determine what steps can be taken to mitigate the increased risk

caused by COVID-19 in patients with hip fracture. Delayed treatment of hip fractures has been proven to increase mortality and complications¹⁷⁾; however, a positive COVID-19 test result adds another variable to this process. Findings from early research during the COVID-19 pandemic indicate that patients who are COVID-19 positive can safely undergo surgical intervention as long as appropriate steps have been taken to medically optimize patients perioperatively¹⁸⁾. Findings from studies have demonstrated that implementation of protocols to promote prompt orthogeriatric assessments, expedite patient transfer, limit operating room traffic, and optimize anesthesia time can preserve the standard of care in this unique population of hip fracture patients^{11,18,19)}. These strategies can be helpful in expediting patient care and early surgical intervention despite the positive COVID-19 status. Conduct of further studies for comparison of these differing strategies is warranted, and the findings of our study clearly demonstrate the gravity of understanding these decisions regarding patients with hip fracture.

Pre-COVID-19 literature suggests that the risk of mortality is significantly increased postoperatively for patients with hip fracture. In-hospital mortality in hip fracture patients is reported to range between 2% and 24%, while 1-year mortality of any cause ranges as high as 14-36%^{17,20-22)}. The additional risk due to the COVID-19 pandemic resulted in a need for reevaluation, which is the aim of our study. It is also worth noting the age distribution in these patient populations and the effect that this factor has on mortality rates. Hip fractures commonly affect elderly patients, with over 90% occurring in patients over the age of 50²¹⁾. Evidence has also shown that COVID-19 mortality increases exponentially after the age of 50²³⁾. These overlapping trends indicate a heightened risk in the elderly, which may affect hip fracture patients in increased magnitude compared to other orthopedic patients.

Main causes of mortality in postoperative hip fracture patients include pneumonia, cardiovascular complications, and thromboembolic events²⁴⁾. The impact of COVID-19 on these complications is currently unclear. Early studies reported significantly higher rates of postoperative pulmonary and thrombotic complications for COVID-19 positive patients undergoing generalized surgical procedures compared to those with negative COVID-19 test results, which likely resulted in increased mortality rates^{7,8)}. Respiratory complications are already a significant factor in the mortality rates following surgical interventions for treatment of hip fractures. Our data suggests that even if a COVID-

19 positive patient is asymptomatic at the time of surgery, the presence of the virus still increases mortality rates, likely through increased risk of complications such as respiratory failure, pulmonary embolism, and pulmonary infections. Thus, despite the patient's asymptomatic status, the presence of the COVID-19 virus may still decrease the patient's chances of surviving these postoperative complications. In addition, the potential for the patient to become symptomatic at a later date may place the patient at greater risk if the symptoms develop while the patient is in a postoperative state, potentially leading to increased risk of complications and decreased chances of survival. Future studies should focus on the effect of COVID-19 on specific complications, with the hope of identifying modifiable risk factors, protocols, and strategies. It is also worth noting that because the COVID-19 positive patients in this study were all asymptomatic at the time of surgery, it is unclear whether different outcomes would be obtained with symptomatic COVID-19 positive patients, and this difference should be examined in subsequent investigation.

As a result of the COVID-19 pandemic, transformation of healthcare and delivery of surgical services is occurring at a magnitude that is unparalleled in modern history^{25,26)}. It is imperative that the orthopedic community make an effort to understand the effect that the pandemic will continue to have on patient outcomes. The short-term and long-term effects of COVID-19 on these mortality rates be profound, and may lead to modification of surgical practices.

This study has some inherent limitations. The retrospective nature of the study limits the data points that can be collected and the number of patients that were lost to follow-up can present a selection bias that potentially affects the mortality rates presented. In addition, the COVID-19+ cohort is very small, limiting the power of our comparisons; however, for this we are limited by the number of patients with COVID-19+ tests who underwent procedures. However, results of our own post-hoc power analysis revealed power similar to that reported by other studies investigating mortality rates following hip fracture surgery²⁷⁻²⁹⁾. There may also be some confounding factors, such as pre-existing pulmonary disease, which could contribute to increased length of stay, which has been shown to increase mortality following hip fracture surgery. However, any factor that could possibly confound our results was already accounted for during our regression analysis. Last, we were only able to capture time of admission to surgery rather than time from injury to surgery as was accurately reported in the electronic medical record. However, this is a minor limitation since patients

presenting with hip fractures to the emergency department at our institution are typically seen on the same day, within a few hours, following their injury. Despite these limitations, this study presents the current picture of hip fracture surgery during the COVID-19 pandemic and the increased risks involved in treatment of COVID-19+ patients.

CONCLUSION

Investigation of the effect of the COVID-19 pandemic on various specialties in healthcare is still underway. Orthopedic trauma is no exception, and the patient subset with the highest mortality risk postoperatively is the same group carrying the highest risk of mortality from COVID-19 infection. Results of this study show an increased mortality rate at 30 days in asymptomatic COVID-19+ patients undergoing hip fracture surgery. Optimizing these patients for surgery to mitigate these risks should be the aim of further investigation.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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